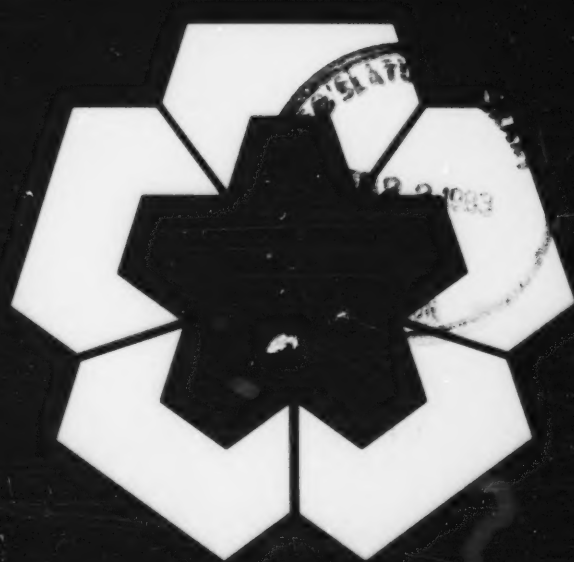


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**Research Management
Division
Annual Report
For the Fiscal Year 1981/82**

RMD Report 82/11

Alberta

RESEARCH MANAGEMENT DIVISION LOGO

The logo represents the interdisciplinary and holistic nature of the Division's environmental research programs. Each of the five sections of the symbol represent comprehensive programs on air, water, land, humans and their constant interaction. The sections converge to form a cohesive chain, characteristic of an effective research organization. This cohesive bonding makes the sections blossom into the environment in the form of a flower — an Albertan wild rose.

RESEARCH MANAGEMENT DIVISION
ANNUAL REPORT
FOR THE FISCAL YEAR
1981/82

Research Management Division
Alberta Environment

For further information on reports published by the Research Management Division, contact:

Research Management Division
14th Floor, Standard Life Centre
10405 - Jasper Avenue
Edmonton, Alberta
T5J 3N4
(403) 427-3946

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RESEARCH MANAGEMENT DIVISION

ANNUAL REPORT

FOR THE FISCAL YEAR

1981/82

RESEARCH MANAGEMENT DIVISION
Alberta Environment

RMD 82/11

December 1982

This report is made available as a public service. The Department of Environment neither approves nor disagrees with the conclusions expressed herein, which are the responsibility of the authors.

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INTRODUCTION

This is the second annual report for the Research Management Division (RMD) of the Department of Environment. The division was formed in April 1980 by combining two units: the Research Secretariat, and the Alberta Oil Sands Environmental Research Program (AOSERP).

The Research Secretariat was the research management and administration arm of the Department of Environment. AOSERP was an independent research program, established in 1975 to fund, direct and co-ordinate environmental research in the Athabasca Oil Sands area of northeastern Alberta. The amalgamation of the two into a single division has resulted in more effective management of scientific research for the Department of Environment.

The Research Management Division provides a research support service to the Department of Environment by identifying, funding, managing, and reviewing research projects in the oil sands and non-oil sands regions; providing scientific advice to departmental staff; reviewing research reports and assessing their relevance to the department's responsibilities; representing the department on departmental, interdepartmental, and interagency committees; co-ordinating interdepartmental and interagency research programs; preparing research review documents; publishing research reports; and operating the departmental library.

Division Organization

At the beginning of the 1981/82 year, the Research Management Division had been organized into four systems (Figure 1): (1) Air, (2) Human, (3) Terrestrial, and (4) Water. Correspondingly, RMD staff was organized into four teams, with research into environmental problems being directed to the most relevant of the systems. Support for their activities was provided by other staff working in Operations and Information.

During the fiscal year, however, the Research Management Division was restructured to develop an integrated interdisciplinary basis for research programs pertaining to both short- and long-term

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J. SHAH] --> DivSec[DIVISIONAL  
SECRETARY  
E. PRINCIPATO]
    Director --> Program[PROGRAM]
    Program --> Air[AIR]
    Program --> Water[WATER]
    Program --> Human[HUMAN]
    Program --> Terrestrial[TERRISTRIAL]
    Program --> Admin[ADMINISTRATION]
    
    Air --> AirSM[SENIOR RESEARCH  
MANAGER  
H. SANDHU]
    Air --> AirRI1[RESEARCH ASSISTANT]
    Air --> AirRI2[RESEARCH ASSISTANT]
    AirSM --> AirMInt[RESEARCH MANAGER  
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N. REHN]
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EDITOR  
J. LOWRY]
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MANAGER  
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Figure 1. Organizational chart of Research Management Division.

environmental problems and priorities. To this end, the functional management mode was replaced by a program management mode which combines the best features of hierarchical and matrix management.

Central to this change in organizational structure has been the re-direction of budgetary allocation to the following broad program thrusts:

1. AOSERP
2. Acid Precipitation
3. Environmental Contaminants
4. Waste Management
5. Environmental Assessment
6. Technological Assessment
7. Socio-economic Analysis
8. Risk Management
9. Environmental Emergencies
10. Reclamation
11. Unsolicited and Basic Research

The previously-existing systems have been retained only as a focus for expertise and for administrative convenience. The library is a separate organizational unit within RMD, and is headed by the departmental librarian. It provides service directly to departmental staff and to the general public, and remains unaffected by the structural change.

The new program management mode offers several advantages over the previous organizational system. For instance, it brings together the expertise from all systems to arrive at solutions to environmental problems in an integrated manner. This integration ensures, in turn, that scientific research programs initiated by RMD are relevant to departmental priorities and objectives. Furthermore, due to its inherent flexibility, the program mode permits reasonable adjustments to research programs as departmental priorities change.

The change in organization has created a new emphasis on the objectives of the Research Management Division. These objectives,

which are directed toward providing an integrated approach to environmental problems and issues, are as follows:

1. To provide timely and authoritative scientific and technical information to other operational units within Alberta Environment. Research by RMD will involve other units within Alberta Environment and will co-ordinate with other government departments, agencies, and industry.
2. To devote most of the RMD budget to major research and development programs which are essential to the present and future environmental protection needs of Alberta Environment.
3. To generate information which is applicable to the development of strategic and long-term operational departmental plans.
4. To produce, or co-ordinate the production of, scientific information whose excellence attracts national and international attention.

An External Advisory committee has been formed to strengthen the Research Management Division and ensure that its new objectives will be met. This committee is composed of senior officials from various government agencies, industry, and universities.

Operational Activities

The research strategies developed by RMD scientists have aimed at improving the quality of research, and at achieving greater success in the incorporation of research results into Alberta Environment's programs and decisions. The Research Management Division supports basic research only when it is identified as essential in support of prioritized departmental research requirements. Funding of research has been almost exclusively by contract.

RMD scientists annually review more than 100 research proposals which are submitted to or solicited by the department. Staff

members also examine numerous research and project reports sent in to the department or to committees of which they are members.

In the past year, a total of 98 contracts were processed. Sixty of these were for research projects contracted to consulting companies and universities. The remainder were service contracts related to reviews, publications, seminars, and analyses. In addition, 16 research grants were awarded to Alberta universities and professional societies. Of these grants, four were used in conjunction with scientific symposia and conferences.

In the 1981/82 fiscal year, RMD was represented on 43 committees, seven being departmental committees and the remainder interagency or interdepartmental committees. Participation in these committees has enhanced the effectiveness of the division and its management capabilities. These activities have also ensured that professional staff have maintained an awareness of current environmental research activities in Alberta and elsewhere. To this end, RMD staff attended and presented papers at scientific conferences and meetings in a variety of locations in Canada and the United States. In addition, they sponsored workshops and seminars on various research topics.

An important aspect of divisional management has been the continuing development of both the technical and managerial expertise of the staff. All scientists attended numerous conferences or seminars, and participated in management courses. Several prepared decision packages, and all initiated and maintained contacts with other scientists to keep abreast of current developments in science and management.

The total divisional budget (Table 1) is approximately \$3.6 million. However, actual monies spent by Alberta Environment on environmental research exceeded this amount because some projects receive funding from such other sources as Pollution Control Division, Alberta Environment; Land Conservation and Reclamation Council-Heritage Trust Savings Fund; and several corporations within the energy

Table 1. Monies administered by the Research Management Division.

<u>Non-Oil Sands Research^a</u>			
	1979/80	1980/81	1981/82
Administration	--	\$ 280 611.00	\$ 456 634.00
Projects (RMD funds)	\$355 716.00	\$ 463 000.00	\$ 366 519.00
Alberta Environmental Research Trust (direct)	\$238 000.00	\$ 240 000.00	\$ 440 000.00
Grants	\$116 635.00	\$ 116 000.00	\$ 212 500.00
Assets	--	\$ 6 000.00	\$ 6 000.00
TOTAL	\$710 351.00	\$1 105 611.00	\$1 481 653.00
<u>Oil Sands Research^b</u>			
Administration	\$ 721 452.00	\$ 694 000.00	\$ 582 532.00
Projects	\$2 189 748.00	\$1 170 550.00	\$1 438 607.00
Grants	\$ 88 800.00	\$ 38 000.00	\$ 30 000.00
Assets	--	\$ 97 450.00	\$ 41 000.00
TOTAL	\$3 000 000.00	\$2 000 000.00	\$2 092 139.00

^a From 1979/80 managed by Research Secretariat

^b From 1979/80 managed by AOSERP

resources industry. Many of these additional funds are managed by RMD scientists.

As indicated by its \$2 million budget allocation, research in the oil sands region of the province was given a high priority by the division. A further \$1.5 million was provided for environmental research in the non-oil sands area. The results of these research activities are readily demonstrated in the 41 publications released by RMD during the 1981/82 fiscal year.

Field support staff in the Division maintained an office in Fort McMurray and a research facility at Mildred Lake in the Athabasca Oil Sands region. Responding to the needs of industry, RMD allowed its facilities at Mildred Lake to be used by industry on a cost-plus-recovery basis.

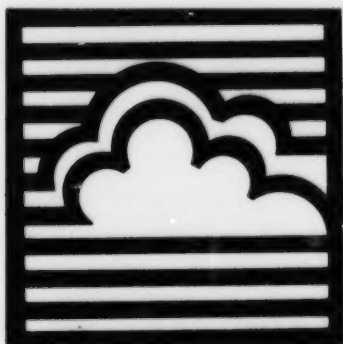
Finally, the Research Management Division is responsible for co-ordinating the development of the department's research requirements for the Alberta Environmental Centre (AEC) at Vegreville. Committees established by RMD staff have identified several projects in the Air and Water systems. Additionally the Director of RMD represents the department on the Technical Advisory Committee to the Centre.

A Note as to the Organization of this Report

As the new organizational structure came into existence after the beginning of the 1981/82 fiscal year, the systems concept has been retained in this annual report to describe the Division's projects and activities. The 1982/83 annual report will, however, fully reflect the transition within the Division's organizational structure. The change in orientation can, however, be recognized in those project descriptions which indicate a project was carried out in conjunction with another system.

The library had existed, and continues to exist, as a separate operational unit providing a service to the entire department.





Air System



ACCOMPLISHMENTS IN THE AIR SYSTEM

The Air System manages research in the areas of air quality, especially long range transport of air pollutants, and urban, rural, and industrial air quality.

During the 1981/82 fiscal year, a slight change in the research direction of the Air System was implemented for the AOSERP area (Athabasca Oil Sands). While the acquisition of baseline data decreased, new technology was used in remote sensing of the atmosphere. The capabilities of acoustic doppler radar to remotely sense atmospheric parameters has encouraged the Air System to develop research projects in this area. Initial project planning and the acquisition of an acoustic sounder has been completed. To conduct further research in this area, a co-operative project has been undertaken with industry to assess the accuracy and reliability of acoustic sounder data as compared with conventional technology.

Research continues to be active into the transport and removal of anthropogenic pollutants by atmospheric processes. A fifth summer-precipitation chemistry project was completed with the co-operation of the Alberta Environmental Centre and the Alberta Forest Service. The major ions and the heavy metals present in the precipitation were determined. This analysis has provided further documentation of deposition patterns over the Athabasca Oil Sands area.

The depth of the snowpack was also surveyed again to supply a continuing record for climatological studies. This survey also gave support to the ongoing studies of the region's hydrology.

The emphasis on model development shifted toward the applications research area. A user-oriented frequency distribution dispersion model was finalized, and its applications to air quality studies were reviewed. In addition, windflow patterns in the oil sands area were studied through the use of a mesoscale, small area wind model. Through the development and use of these models, information gaps were identified, leading to initiation of a joint government/industry project designed to assess meteorological data acquisition systems and, if necessary, replace the present network.

The Air System has worked closely with the Terrestrial System to co-ordinate meteorological and air quality information required for an ecosystem monitoring project. Output from a dispersion model was synthesized to assist in sample plot locations. Co-ordination of air quality instrumentation for the project was also undertaken by Air System personnel.

Edmonton and Calgary are the two fastest growing cities in Canada, and their growth has brought air pollution. As a result, understanding urban air quality is a high priority with the Air System. Projects related to particulate matter, visibility, and aerosols were completed for Edmonton and Calgary. Modelling activities related to air quality and the valley effects in the Edmonton area were finalized. Also undertaken was research work to understand, under Alberta conditions, the formation and removal of secondary pollutants in the two major urban centres. These studies will provide the necessary baseline information for determining trends in air quality for these cities which are expected to double in size by the year 2000.

Air System managers represented the department on numerous provincial, federal/provincial and international committees dealing with trans-boundary air pollution, and particularly with concerns related to acid rain and long-range transport of air pollutants (LRTAP). An Air System manager was named co-ordinator and spokesman for departmental activities on acid rain and LRTAP. A report was published on monitoring and research activities related to acid rain and LRTAP in Western Canada.

A Steering Committee on Acid Gases in the Environment (SCAGE) was created in 1979 by the Alberta Petroleum Industry/Government Environmental Committee (APIGEC) to produce a research program to address acid rain concerns of the public, the petroleum and power industries, and the Alberta Government. An Air System manager chaired this committee, which developed and submitted the proposed final research program to APIGEC for its consideration.

During the 1981/82 fiscal year, the increased concern about acid emissions in eastern Canada also heightened the concern of the

public, industry, and government in Alberta. The Research Management Division sustained the development of a long term research program on acid emissions, in co-operation with industry, other departments, and other government agencies. A jointly sponsored Industry-government Symposium/Workshop on Acid Forming Emissions In Alberta and their Ecological Effects was organized with the assistance of the Air System. More than 200 participants from government, industry, universities, environmental groups, news media and the public attended this event. Proceedings containing keynote addresses and research papers have been published.

The Senior Research Manager chaired a National Research Council panel which has completed the task of publishing a scientific criteria document entitled "Hydrogen Sulphide In the Atmospheric Environment: Scientific Criteria for Assessing Its Effects on Environmental Quality." The manager was invited last year to become a member of the National Research Council's Associate Committee on Scientific Criteria for Environmental Quality. This brought scientific credibility to the Division and to the Department.

Climatic change and variability, and their impact on natural and human resources were discussed at the Climate Change Seminar organized by the Canadian Council of Resource and Environment Ministers. Recommendations of the Steering Committee were accepted by the Council, and Alberta was invited to become a member of the Canadian Climate Planning Board. The Air System's Senior Research Manager was named to this Board. An inventory of Alberta government climate data collecting programs and an assessment of future co-ordination was compiled, and will be published soon.

PROJECTS

Airshed Management Modelling Systems for the AOSERP Area Phase III

This project was undertaken to develop a model capable of providing a versatile, user-oriented display of frequency distribution and average ground-level concentrations of pollutants. It will furnish managers with information relating pollution of the AOSERP area to future development needs.

Funding: \$11 000.00

Air Quality Data Acquisition in the AOSERP Area

At ten monitoring sites in the oil sands production area and one in the town of Fort McMurray measurements were made for sulphur dioxide, carbon monoxide, hydrogen sulphide, nitrogen oxide, and particulate matter. These values were monitored in conjunction with nine meteorological stations. Data summaries are available from RMD.

Funding: \$140 000.00 (Jointly funded by Research Management Division and Pollution Control Division)

AMOCO Gregoire Lake Monitoring Program

Ground level concentrations of sulphur dioxide, carbon monoxide, nitrogen oxides, and particulates were measured in the vicinity of the in situ pilot plant near Stoney Mountain. Surface meteorological parameters were also measured.

Funding: \$27 500.00

Assessment of Collection and Handling of Climate Data by Alberta Government Agencies

Climatic data, including air quality and meteorological parameters, is collected in Alberta by many different government agencies. There is a great need to co-ordinate the collection and archiving of this data, as identified in the Canadian Council of Resource and Environment Ministers (CCREM) recommendations. The intent of this study was to assess the present state of these climatological

networks and archives, and to recommend methods of co-ordinating present and future data archiving within government agencies.

Funding: \$20 000.00

Computer Modelling of Low-Level Winds and Temperatures over the Southeastern AOSERP Study Area

A low-level planetary boundary layer model has been adapted to the central AOSERP study area to provide low-level winds and temperatures. It incorporates the effects of topography and thermal circulations on low-level wind flow. The model formulation requires less detailed meteorological initialization than did a previous version, yet maintains the same physical processes. This will allow it to be adapted more easily to other areas of Alberta where detailed input data are not available.

Funding: \$9 460.00

Doppler Sodar Measurement of Wind Climatology of Calgary

Acoustic sounders appear to offer a practical and relatively inexpensive method of obtaining wind profiles from the ground surface up to several hundred metres. A sounder was installed at Springbank Airport, near Calgary, to measure wind speed and direction at altitudes between 75 and 500 m. These data have been examined to determine their statistical properties and have been compared with winds measured near ground level at four sites in the Calgary area. Results indicate that there are stronger topographic influences on the ground level winds as compared to the upper winds.

Funding: \$32 220.00

Event Rain Sampling in the Oil Sands Area

The objective of this project was to sample rain events at 15 locations in the oil sands area. Chemical analyses for sulphate, nitrate, chloride, ammonium, potassium, calcium, sodium, magnesium, and pH provided data for the evaluation of deposition rates.

Funding: \$35 000.00

Modernization of AOSERP MAPS Automatic Reporting Network

Investigations were conducted to evaluate the design and cost for modernization of the AOSERP MAPS Automatic Reporting Network. The alternatives are either to repair and upgrade the existing components; to procure and implement a new, state-of-the-art system; or to effect a combination of these two. It appears that a decision will soon be reached.

Funding: \$7 000.00 (Jointly funded by the Research Management Division and Syncrude Canada Ltd.)

Oil Sands Extraction, Upgrading and Emission Technology Review

The attainable performance of abatement technologies with respect to gaseous emissions and to recovery of sulphur is limited by the available technology at the time of application or final design. To update the 1976 report "Evolution of Pollution Abatement Technology as Applied to the Alberta Oil Sands," prepared by Western Research and Development, a study was proposed to review literature sources and to contact process licensors and vendors for the most current technological developments and processes.

Funding: \$90 000.00

Peroxyacetyl Nitrate in the Calgary Atmosphere

Ambient concentrations of peroxyacetyl nitrate (PAN) and peroxypropionyl nitrate (PPN) in the Calgary atmosphere were determined. Diurnal and seasonal variations were also measured. Rates of photochemical formation were established along with the removal of PAN in relation to the intensity and duration of solar radiation, the abundance of primary atmospheric pollutants, and varying meteorological conditions. The potential for correlating PAN with human health effects was also examined.

Funding: \$65 000.00

Snowpack Chemistry in the Oil Sands Area

The objective of this study was to determine the pattern and rate of winter deposition of pollutants. To compile a final report,

snow samples were analysed for chemical constituents, and the results were compared with a 1976 survey.

Funding: \$9 048.00

Sulphur Isotope Abundances in the Environment and their Relation to Long-Term Sour Gas Flaring near Valleyview, Alberta

Over 300 sulphur concentrations and isotope abundance analyses were carried out on stack gas, atmospheric sulphur dioxide, particulate matter, rain, surface waters, soil, vegetation, crop seeds, and fertilizers. Samples were taken between May and December 1980 within 20 km of the Amerada-Hess Gas Plant flaring operation. These data were used to assess the long-term environmental impact of sour gas flaring. Changes in pH upon acid addition were used to crudely assess the buffering properties of soil horizons.

Funding: \$5 000.00

TAGA Ambient Air Monitoring Survey

The objectives of this study were to sample and analyse ambient air in the vicinity of selected industrial sites in Alberta. The chemical composition of these ambient air samples was used to identify and track selected pollutants. The chemical analyses were conducted by employing a TAGA 3000 Mobile Laboratory.

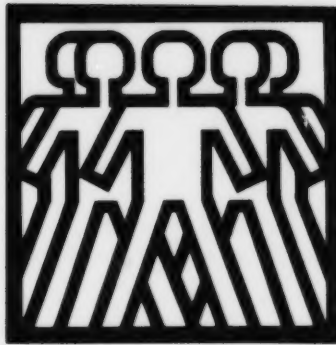
Funding: \$50 000.00 (Jointly funded by the Research Management Division and Pollution Control Division)

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Human System

5

ACCOMPLISHMENTS IN THE HUMAN SYSTEM

The Human System is concerned with social impact assessment (including public participation), environmental education, human-biophysical environmental relationships, environmental health, environmental attitudes, and research management, policy and implementation.

With the hiring of a new research officer in February 1982, the Human System now has its full complement of staff. A document outlining the mandate for the Human System is presently before senior management for review.

The Human System has almost completed its synthesis of the AOSERP data from the last five years. Field data on family adjustment in Fort McMurray were translated into policy-relevant information. This enables research data to be used more readily by decision makers.

The Human System conducts projects outside the oil sands area for in-house client groups--the Environmental Assessment Division, Planning Division, Communications Branch, and Restricted Lands Branch. The projects fall into four major areas:

1. Socio-economic impact analysis;
2. Public participation;
3. Human-environment relationships; and
4. Research management and policy analysis.

In the area of social impact assessment, Human System contributions included acting as program co-ordinator for the Alberta Forum on the Human Side of Energy, held in Edmonton during August of 1981. This conference attracted 375 participants representing government, industry, universities, communities, environmental groups, and news media from all over the United States and Canada. The results of the conference will provide added input to the Third Conference to be held in Knoxville, Tennessee during August 1982. A Human System research manager is a member of the international steering committee on the Human Side of Energy. Evaluations of community impact studies were also carried out on behalf of the Environmental Assessment Division.

Activities in the public participation area consisted primarily of serving as advisor to field staff of the Public Participation Branch and Planning Division in the evaluation of their programs, for example, the Buffalo Lake Stabilization Program, and the South Saskatchewan River Basin Planning Project.

The program on human-environment relationships has two sub-programs. The first is environmental health, involving reviewing and evaluating the terms of reference for a health study in Fort MacKay. The second sub-program concerns environmental attitudes. The Human System continued the inclusion of environmental questions in the Edmonton Area Survey, carried out by the Population Research Laboratory at the University of Alberta.

The area on research management and policy analysis included two major studies. The first resulted in a document laying out a research management framework for the Human System. Data from Fort McMurray has been re-analysed and interpreted in the second study to help policy formulation by the New Town Planning Board in Northeast Alberta. A paper written by Human System staff on this project will soon be appearing in a refereed journal.

PROJECTS

An Integration and Synthesis of AOSERP Human System Research Results

Since 1975, data have been collected under the auspices of AOSERP to determine the changes that have taken place in the oil sands area due to the development of the area's resources. This project will provide a synthesis of the data collected to date.

Funding: \$15 538.00

Edmonton Environmental Survey

A yearly survey is conducted by the Population Research Laboratory, University of Alberta. The survey is taken of a large sample population in Edmonton and covers many subject areas. Each year the Human System funds the Population Research Laboratory for the inclusion of questions about the environment in order to gauge points of view on that subject. The first report is expected July 1982.

Funding: \$3 000.00

Human Side of Energy

A forum on the Human Side of Energy was held in August 1981 at the University of Alberta. It attracted 375 people from the United States and Canada, who discussed issues of energy development as they affect human populations. Included were such topics as: planning for energy development; impact of megaprojects on Albertans; and the future of native participation in Canadian resource development.

An issue of the Department of Environment magazine, Environmental Views, was based on this forum. A set of abstracts from the papers presented at the forum is available through the Faculty of Extension, University of Alberta.

Total Funding: \$20 030.00 (Jointly funded by the Research Management Division and the Environmental Assessment Division)

Policy Analysis of Fort McMurray Data

Data collected in a 1979 field study of family adjustment in Fort McMurray was re-analysed and re-interpreted in the light of planning and policy options for the proposed new town in northeastern Alberta. Policy options data were provided by the New Town Planning Board. The re-interpreted information can be used for future planning.

Funding: \$16 500.00

Research Management Framework

An orderly, rationalized way of conducting research was commissioned by the Human System. This included close interaction with the management consultant to ensure that the framework matched the changing needs of the system. A five-page digest is in the process of being written and will be made available.

Funding: \$10 900.00

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Terrestrial System



ACCOMPLISHMENTS IN THE TERRESTRIAL SYSTEM

The Terrestrial System is involved in research in the areas of biological monitoring, reclamation, and the effects of air pollutants on terrestrial ecosystems.

Reclamation research by Alberta Environment was co-ordinated by the Reclamation Research Co-ordinating Committee, chaired by a Terrestrial System scientist. Another scientist continued essentially full-time managerial and administrative responsibilities for reclamation research in association with the interdepartmental Reclamation Research Technical Advisory Committee (RRTAC). In 1981, RRTAC committed approximately \$1.5 million to a reclamation research program with sub-programs in the northeast oil sands region, in the coal-bearing region of the province's agricultural zone, and in the mountains and foothills.

The Terrestrial System has been conducting a review of reclamation research for Alberta. A bibliography of some 2000 references, with computer search capability, was prepared, and work was begun on a synthesis report of references relevant to Alberta.

The Canadian Land Reclamation Association Newsletter was edited by a Terrestrial System research manager.

The Terrestrial System provided assistance in the organization of the Symposium/Workshop on Acid Forming Emissions in Alberta and their Ecological Effects. A System manager co-chaired the Terrestrial Workshop held on the final day of the symposium.

Terrestrial System scientists continue to co-operate with other division managers on scientific projects and programs relevant to the Department. Scientific expertise and management capability is also provided to outside agencies such as the Alberta Environmental Research Trust, the Energy and Natural Resources Forest Development Research Trust, and to the Canadian Petroleum Association/Environmental Research Advisory Committee.

PROJECTS

A Study of the Effects of Low Levels of Ethylene Gas on the Growth of Crop Plants

This study was designed to determine the effects of long-term, low-level exposure to ethylene of typical Alberta crops and the effects of pulses of more concentrated ethylene, especially at sensitive periods of plant growth.

Funding: \$70 000.00 (Jointly funded by Alberta Gas Ethylene and Dow Chemical Company of Canada Ltd., the Research Management Division, and the Pollution Control Division)

Assessment of Reclamation Potential and Hydrologic Impacts of Large-Scale Surface Mining of Coal in Plains Areas of Alberta

The objective of this project was to develop a predictive framework that will permit a projection of success for reclamation and of the long-term impact of mining on water resources. Differences in physical and chemical properties of the pre-mining soils, overburden, and subsurface water were used as keys to project post-mining conditions. The predictive framework is to be based on an understanding of the processes acting within the landscape so that, in the future, mine sites that are not totally analogous to those that have been studied can also be evaluated.

The project involved an holistic approach to reclamation through the integration of studies on geology, hydrogeology, and soils, not only in a proposed mining area, but also in the adjoining unmined areas. This approach permits the assessment of impacts and long-term performance in both areas.

Funding: \$1 065 526.00 (Land Conservation and Reclamation Council-Heritage Trust Savings Fund)

Battle River Reclamation Research Project

This study was designed to determine the types and amounts of materials needed to amend sodic mine spoils. The ability to

restore and maintain agricultural productivity will be a measure of the success of the various amendments.

Funding: \$41 167.00 (Jointly funded by Land Conservation and Reclamation Council-Heritage Trust Savings Fund, Alberta Power, Luscar Ltd., and Manalta Coal Ltd.)

Distribution and Relative Sensitivity to Acidification of Soils, Sand River Area, Alberta

This study has developed preliminary criteria for estimating soil sensitivity to acidification. A final report, applying the criteria to soils of the Sand River area, will be released in August 1982.

Funding: \$7 000.00 (Funded by Research Management Division; co-operatively funded with Canadian Petroleum Association in previous years)

Feasibility of Genetic Improvement of Native Alberta Grasses

This project is attempting, through mass selection, to develop improved lines of native Alberta grasses for reclamation, erosion control, and wildlife range improvement in alpine and subalpine areas of Alberta. Six test sites were established in 1981 to provide the data required for licence application; three species of Agropyron are being tested against commercial varieties.

Licensing may be possible as early as 1983. Selection of several high-elevation species is continuing.

Funding: \$163 290.00 (Funded by Land Conservation and Reclamation Council-Heritage Trust Savings Fund, and Parks Canada)

International Inventory of Fertility Analysis for Peat Soils

Peat fertility is a poorly understood subject that has received minimal investigation in North America. Under the auspices of the International Peat Society, a Terrestrial System scientist is

compiling an inventory of peat analyses methods from international research institutes where more relevant research has been carried out. The inventory will be used to help develop standard international methodology for peat analysis.

Funding: \$2 500.00

Investigation of Chemical, Physical and Biological Parameters in Stored Topsoil

The effects of stockpiling topsoil on chemical, physical and biological properties were examined in this study. The information will assist mine managers in the scheduling of materials handling for the most productive reclamation.

Funding: \$17 600.00 (Funded by Land Conservation and Reclamation Council-Heritage Trust Savings Fund)

Investigations of Enhanced Growth in Grass Species with Root Microorganisms Associations

A survey was commissioned by the Reclamation Research Technical Advisory Committee to confirm and assess the occurrence of root sheaths on plants growing on reclaimed and undisturbed areas. Correlations were made between plant vigour and root sheath occurrence. N-fixing rhizosheaths were found more commonly on grasses growing on disturbed sites than on undisturbed sites. Laboratory studies funded by the Alberta Environmental Research Trust (AERT) are now under way to isolate and identify the N-fixing organisms. When available, the resulting inocula will be tested under field conditions to determine whether they have value as a reclamation treatment.

Funding: \$8 690.00 (Funded by Alberta Environmental Research Trust)

Land Disposal of Oily Wastes

Some 10 000 m³ of oily waste sludges are produced annually by the province's oil industry. Land disposal of oily wastes is being considered as a more environmentally-sound practice than are current disposal techniques. Laboratory experiments have begun to

provide preliminary information on the feasibility of the technique. If the results are positive, field research will begin in 1982.

Funding: \$80 000.00 (Jointly funded by Alberta Environmental Research Trust, Canadian Petroleum Association, and Alberta Oil Co-operatives)

Mycorrhizal Development on Severely Disturbed Soils

This study has examined the effect of various amendments on mycorrhizal development in mine spoils from plains, mountains, and the other Athabasca oil sands. Future emphasis will be placed on examining the potential of natural inoculum in stored peat and on developing effective mycorrhizal associations for oil sands reclamation.

Two reports presenting a synthesis of information collected from tests in large soil tanks at the University of Calgary are expected to be published in 1982/83.

Funding: \$41 485.00 (Funded by Land Conservation and Reclamation Council-Heritage Trust Savings Fund)

Oil Sands Soil Reclamation Project

A major literature review was undertaken to define the minimum physical, chemical, and biological properties of soil manufactured from tailings sand and locally-available materials to support three vegetation types. These include vegetated tailings pond dyke slopes, mixed wood spruce/aspen forest and jack pine forests on mined areas. Knowledge gaps will be identified and recommendations for further research provided. The final report is expected to be published in 1982.

Funding: None in 1981/82

Reclamation Research Review

International reclamation literature has been collected by RMD staff and compiled in a bibliography. A computer program has been developed to allow users to search the bibliography. The data

base is kept on a SPIRES file at the University of Alberta. The bibliography and Searching Manual will be published early in 1982.

RMD staff are preparing a synthesis of literature referenced in the bibliography. This report will provide direction for further research in the province.

During the assembly of references for the bibliography, reports and publications containing information useful for the preparation of environmental impact statements and for reclamation planning were compiled separately. A bibliography of such information which is available in the Alberta Environment Library is being published separately.

Funding: \$3 900.00 (Funded by Land Conservation and Reclamation Council-Heritage Trust Savings Fund)

Reinstatement of Biological Activity in Devastated Soils

This study looked at the nature and rate of microorganism establishment in spoils, and at the influence of various reclamation treatments in establishing a stable plant-soil system. The project included both laboratory and field work, and studied spoils produced by Plains coal mining, Mountain and Foothills coal mining, as well as oil sands mining and extraction.

Two final reports are in preparation and are expected to be published in 1982/83.

Funding: \$44 916.00 (Funded by Land Conservation and Reclamation Council-Heritage Trust Savings Fund)

Role of Organic Compounds in the Salinization of Plains Coal Mining Sites

This study has attempted to determine the sources of sulphur in Plains coal mining spoils, and to determine the extent to which these sources could contribute to salinization of reclaimed spoils as well as the processes involved. Information from this study will contribute to a predictive hydrogeological model for

reclaimed Plains coal areas that is being developed by the Alberta Research Council.

Funding: \$92 000.00 (Funded by the Land Conservation and Reclamation Council-Heritage Trust Savings Fund)

Survey of Reclamation Activities in Alberta

The purpose of this survey was to catalogue reclamation activities in the province. Research was the primary target but operational reclamation, and reclamation planning in the form of literature reviews, field trials, demonstrations, and pre-disturbance surveys were all included in the report. The survey was published in June 1981.

Funding: None in 1981/82

The Effects of Nitrogen Oxides on Native Vegetation, Soils, and Water Near a Compressor Installation

This study will determine the sensitivity of select natural plant species to injury or damage by low concentrations of nitrogen oxide and/or nitrogen dioxide stress. It will also determine the effects of nitrogen oxide and/or oxides on the availability of certain plant nutrients in the soil.

Funding: \$138 384.00 (Jointly funded by the Research Management Division and the Pollution Control Division)

The Crowsnest Valley: An Historical and Ecological Assessment of Significant Changes in the Biophysical Environment of the Crowsnest Valley, 1873-1945

This study has attempted to determine the changes which have taken place in the biophysical environment of the Crowsnest Valley in relation to resource extraction activities between 1873 and 1945.

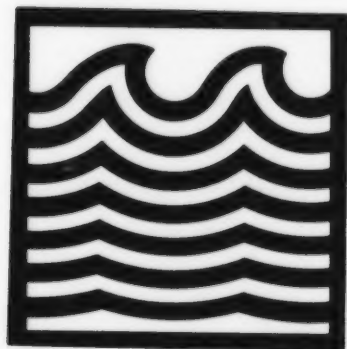
Funding: None in 1981/82

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Water System



ACCOMPLISHMENTS IN THE WATER SYSTEM

Water System research projects in the 1981/82 fiscal year were conducted within six program areas of research: contaminants; waste management; surface water engineering; groundwater; ground deformation; and grants for graduate studies, workshops and seminar speakers.

Monitoring of the water quality and aquatic biota in the Athabasca Oil Sands area continued under the contaminants program. Other ongoing projects under this program involved research into lake phosphorus estimates and in situ oil sands combustion products.

The waste management program emphasized research into solid waste and wastewater management, and involved projects dealing with sanitary landfills, sludge, and sewage products.

Research in the surface water engineering and groundwater programs focused on developing an information base for numerical modelling. Surface water engineering research addressed concerns relating to sediment transport, water conveyance, hydrology, and hydrometrics. Groundwater research included a model inventory and a proposed regional scale modelling of the hydrogeology and hydrochemistry of the Cold Lake Oil Sands deposit.

Ground deformation research continued in the monitoring of slope stability in competent rock at Turtle Mountain and induced seismicity related to in situ fluid injection at Cold Lake.

Speakers were sponsored to present seminars on a variety of relevant topics. Funds were contributed to the Plains Aquatic Research Conference at the University of Calgary. A Water System manager co-chaired the Aquatics Research Workshop for the Symposium/Workshop on Acid Forming Emissions in Alberta and their Ecological Effects.

PROJECTS

A Literature Review of Settlement Behaviour of Sanitary Landfills and their Application to Alberta

This project identified published information on the magnitude and rates of sanitary landfill subsidence and consolidation, and assessed the relevance of such information to Alberta.

Funding: \$5 980.00

A Regional Assessment of Hydrogeological and Hydrochemical Conditions in the Cold Lake Oil Sands Deposit

This project will develop a three-dimensional framework of the hydrostratigraphy, hydrodynamics, and hydrochemistry of the Cold Lake Oil Sands area. It will also identify the processes inherent to both in situ recovery and deep waste disposal methods, and evaluate their possible effects on both local and regional groundwater regimes of the study area. Where significant effects are noted, recommendations will be made for further study aimed at the quantification of these potential impacts for both local and regional scales.

Funding: This project is currently in the decision package preparation stage.

An Electrophysiological Investigation of the Effects of Toxicants on Fish Skeletal Muscle

This project was designed to seek more sophisticated techniques for evaluation of toxicants on aquatic organisms, and to examine a class of problem compounds. This involves the development of a nerve-muscle preparation, and the characterization of this preparation anatomically, physiologically, pharmacologically, and electrophysiologically. The effects of toxicants on this preparation are then to be examined.

Funding: \$5 650.00

Biological Monitoring of the Athabasca River

This project was designed to develop biological monitoring techniques for implementation on large river systems.

Funding: \$12 100.00

Cold Lake Seismic Array

This project will eventually provide baseline seismicity information in the Cold Lake Oil Sands area. Further objectives are: to identify the source locations of the observed events and to identify or suggest their causes; to describe the environmental significance of observed seismic events and their relationship to current activities; to make recommendations concerning ongoing monitoring after the basic study is completed; and to design mitigative engineering features.

Operation of the array and the dissemination of data continues to be carried out by the Earth Sciences Division.

Funding: \$19 395.00

Co-operative Program in Surface Water Engineering

This program is a continuation of joint research projects in fluvial mechanics and river engineering, surface water hydrology, sediment yield studies, ice formation, and breakup in streams. This is a joint program undertaken with the Department of Transportation, Alberta Research Council and University of Alberta.

Funding: \$72 600.00

Development of a Model to Predict Winter Oxygen Deficits in Local Lakes of Central Alberta

This project was designed to measure winter oxygen depletion in several local lakes of central Alberta with a goal to develop a model to predict the process.

Funding: \$6 400.00

Development of the Spirillum Motility Test for Toxicity Studies

This project was designed to develop the Spirillum volutans motility test for toxicity studies, and to increase the sensitivity, accuracy, and the ease of performing this motility test for toxicologically assessing pollutants.

Funding: \$8 000.00

Distribution and Circulation of Water and Sediment in the Athabasca River and Delta

This project was designed to estimate and describe how water from the Athabasca River is distributed through the delta system under various flow and ice conditions and at various levels of Lake Athabasca. It will also estimate and describe the circulation and mixing of river water in Lake Athabasca under various conditions and their relationship to outflows to the Slave River and to cross-connections with Mamawi Lake and Lake Claire. The distribution, circulation, and deposition of sand and fine sediment carried to the mouth of the Athabasca River will be described for both the delta and Lake Athabasca. Flow-specific processes will be related to the possible contamination of the Athabasca River delta by upstream sources.

Funding: None in 1981/82

Flow in Curved Channels: State-of-the-Art

This project was undertaken to obtain and evaluate a consensus on the present understanding of the flow in curved channels. Existing predictive methods and modelling techniques will be identified and catalogued, especially such factors useful for design purposes as the extent of scour, super-elevation, and velocity and shear distributions. Areas most in need of research will be identified.

Funding: \$7 500.00

Hydrology and Sediment Yield of the Muskeg River Basin: Northeastern Alberta

When completed, this project will describe and explain the hydrologic and sedimentologic regimes of disturbed and undisturbed sites in the Muskeg River basin. It will also develop a predictive capability for the magnitude and frequency of flows, and the volume and size characteristics of material entering the river system from upland erosion as a result of the exposure of the mineral soil after muskeg removal.

Funding: \$25 000.00

Hydrometric and Suspended Sediment Network

This is an ongoing project providing adequate streamflow information for an inventory of hydrology resources for the AOSERP study area. The data are to be used in studies of water quantity and quality, water use, flood flow, and modelling. It also provides background information on the temporal distribution of suspended sediment concentrations and discharges in streams within the AOSERP study area.

Funding: \$9 000.00

Improving the Estimates of Phosphorus in Local Lakes

The objectives of this project were to develop a model to predict the portion of the phosphorus pool tied up in the larger plankton of local Alberta lakes, and to improve the models for predicting lake water phosphorus.

Funding: \$32 233.00

Inventory of Groundwater Flow and Chemistry Models

The intention of this project was to produce an inventory of groundwater flow and chemistry models that could be applied to environmental studies of the Alberta Oil Sands.

Funding: None in 1981/82

Laboratory and Field Investigations of Gravel-Braided Stream Morphology

Various aspects of gravel-braided stream morphology and process were investigated by means of a small-scale laboratory model. An attempt was made to collect field data to verify some of the laboratory data.

Funding: \$2 700.00

Modelling the Circulation and Sediment Distribution In the Athabasca Delta Area

This system was designed to provide a calibrated mathematical model capable of predicting the circulation patterns in the southwest end of Lake Athabasca and of indicating concentration distributions under various flow conditions. It also related LANDSAT Imagery to water quality parameters, primarily suspended sediment concentrations.

Funding: \$90 000.00

Oil Sands In Situ Combustion Products

This project was undertaken to chemically identify contaminants in the produced fluids and gases of the in situ fire-flood produced bitumen, and to identify the possible environmental hazards and human health risks arising from these toxic and carcinogenic materials.

Funding: \$100 000.00 (Jointly funded by the Research Management Division and the Alberta Oil Sands Technical and Research Authority)

Oil Sands Tailings Geomechanics

The objective of this project is to determine the nature and extent of oil sands tailings generation, materials balance, sludge behaviour, systems properties, and potentially beneficial treatments from a geomechanics and systems analysis point of view.

Funding: Currently at the proposal stage

Perpetual Residue Management Considerations for Proposed Hazardous Waste Disposal Facilities in Alberta

The intention of this project was to develop a comprehensive understanding of the characteristics of final residues which will be generated by hazardous waste management technologies currently under consideration for implementation in Alberta.

Funding: \$30 000.00

Potential Health Problems Caused by the Disposal of Treated Sewage Products Containing Parasites

This project was undertaken to identify the numbers, distribution, and viability of pathogenic bacteria and parasitic stages from sludged fields, and to assess the effectiveness of the activated sludge process and lagoons with regards to these pathogens. It will also identify worm parasites from slaughter house animals, and assess the degradation rate of pathogens in sludge implanted 20 to 30 cm below the soil surface. It is hoped to extend the existing study to include a viral component.

Funding: \$109 057.00 (Jointly funded by the Research Management Division, Pollution Control Division, and Standards and Approvals Division)

Processing and Analysis of Cold Lake Seismicity Data

This project was initiated to obtain data reduction and analysis services for digital seismic data derived from the Cold Lake Digital Seismic Array. A further objective was to initiate research into induced seismicity phenomena associated with in situ extraction of bitumen from the Alberta Oil Sands.

Funding: \$25 000.00 (Funded by a grant from Esso Resources to the University of Alberta)

Scour and Transport of Coarse Riverbed Material

This project was undertaken to describe and quantify the phenomena associated with bed movement in gravel-bed rivers and how

these relate to the design of pipeline crossings.

Funding: None in 1981/82

Sediments as an Important Source of Phosphorus in Shallow Productive Lakes in Alberta and the Development of a Lake Management Strategy for these Lakes

This project was undertaken to collect data to calculate a nutrient budget for three shallow productive lakes in the Edmonton area, and to estimate the return of phosphorus from the sediments by examining the difference between input and output. The data will be used, along with literature examples, to develop general models for these unusual lakes, focusing both on quantity of nutrient returned, and rates of nutrient return from the sediments.

Funding: \$5 200.00

Study of the Microbiology of the Bow River Emphasizing Slime Partitioning and Its Significance to Public Health

This project was designed to investigate modifications in microflora at sites above, at, and below a major point source effluent into the Bow River. In addition, the relative numbers of potentially pathogenic bacteria were determined. The potential public health significance will be evaluated.

Funding: \$36 310.00 (Funded by the Pollution Control Division,
Municipal Engineering Branch)

Study of the California and other Water Atlas Projects and Proposal for an Alberta Water Atlas Study

The objective of this project was to study the recently-completed California Water Atlas project, as well as other projects for which reference materials are available in California and Alberta, to see what alternative procedures and methods might be used in the development of a Water Atlas of Alberta and to prepare an Alberta Water Atlas proposal. This proposal will include tentative

tables of contents with comments on the options available, outlines of alternative development procedures, and estimates of cost.

Funding: \$9 200.00

Surface Water Quality Management in Alberta: An Analysis of Policy, Institutional Arrangements, and Implementation Decisions

This project was designed to identify, from a policy and institutional perspective, the factors which affect or may affect a comprehensive approach to water quality management.

Funding: \$7 640.00

Systems Analysis of Irrigation Water Conveyance System

This project evaluated the feasibility of developing a physically-based computer simulation model that will permit an evaluation of the factors that influence the overall conveyance efficiency of a typical irrigation district distribution system in Alberta.

Funding: \$31 865.00 (Jointly funded by the Planning Division, River Basin Planning, Southern Region, and the Research Management Division)

The Delineation of the Minimum Principal Stress Value, Determination of Fracture Orientation and Mechanical Investigation of Colorado Clay Shales at the Cold Lake Oil Sands Deposit

This project was initiated to prepare a proposal and work plan for in situ measurement of the value of the minimum principal stress for at least five depths between the top of the Clearwater formation and the first confined aquifer in the drift. The area involved is within the Cold Lake area under the Beverly Channel.

Funding: None in 1981/82

The Role of an Urban Planner in Managing Consumptive Use and Water Distribution for Urban Areas

This project was designed to determine how urban and regional planning can influence water resources in terms of improving

water-use efficiencies and resource conservation. It also examined the role of water resources in shaping urban growth in Calgary. Present and future urbanization trends in Canada were examined, with a focus on Alberta and western Canada.

Funding: \$8 610.00

The Significance of Heavy Metal to the Activated Sludge Process

The pathways and fate of heavy metals entering the Gold Bar Wastewater Treatment Plant will be quantitatively assessed and the effects of these heavy metals on the activated sludge process determined.

Funding: \$13 720.00 (Jointly funded by Research Management Division, Pollution Control Division, and Standards and Approvals Division)

Turtle Mountain Study

This study was undertaken to determine whether a mass of rock outlined by Allan (1933) on Turtle Mountain is in motion and is, therefore, likely to slide into the Crowsnest Valley in the future.

Funding: \$8 052.00

Water Quality Monitoring in the Athabasca Oil Sands

The objective of this project was to collect water quality data in the Athabasca Oil Sands area. The data provide a continuous set of baseline information for the region.

Funding: \$150 000.00

PUBLICATIONS

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- Baker, B.L., T.I. Ladd, S.A. Telang, J.W. Costerton, and G.W. Hodgson. 1982. The biogeochemistry of streams: the Red Deer River. Prep. for Alberta Environment, Research Management Division by the University of Calgary, Kananaskis Centre for Environmental Research and the Department of Biology. RMD Report L-81. 202 pp.
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- MacLaren Engineers, Planners and Scientists Inc. 1982. Evaluation of organic pollutants in sanitary landfill leachate. Prep. for Alberta Environment, Research Management Division by MacLaren Engineers, Planners and Scientists Inc. RMD Report OF-42. 159 pp.

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- Moell, C.E. 1982. Sanitary landfill studies in Alberta, summary of investigations to date. Prep. for Alberta Environment, Research Management Division and Waste Management Branch by Western Soil and Environmental Services. RMD Report OF-41. 151 pp.
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- Neill, C.R., B.J. Evans, and A.W. Lipsett. 1981. Circulation of water and sediment in the Athabasca delta area. Prep. for Alberta Environment, Alberta Oil Sands Environmental Research program by Northwest Hydraulic Consultants Ltd. and the Alberta Research Council. AOSERP Report 123. 182 pp.
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- Olding, B.J. 1981. Approaches to comprehensive water resource management for the Province of Alberta. Prep. for Alberta Environment, Research Management Division by the University of Calgary. RMD Report OF-26. 270 pp.
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Administration

ADMINISTRATION

The 1981/82 fiscal year saw little change within the administrative setting of the Research Management Division. The Office Supervisor manages and co-ordinates the work of the clerical staff under the direction of the Research Administrator. The budgets for the various systems, derived from meetings between the Research Managers and Administration, are based on departmental priorities. Two separate budgets are prepared--one for research in the Oil Sands region (AOSERP) and the other for research in the non-Oil Sands areas.

Research into the various aspects of the Environment is contracted out to consultants, industry, and the universities. The master contract agreements with the University of Alberta, the University of Calgary, and the Research Council of Alberta, and the letter of assignment have been retained. The agreements have reduced the administrative details in contract formalization with these institutions.

RMD has procured an IBM Stand-Alone Displaywriter and Printer to complement the Advanced Text Management System (ATMS) word processor.

Library



LIBRARY

The Library Services Branch provides research support and reference service to Alberta Environment staff throughout the province. The Library is also open to those members of the public, private industry, and the university community who have an interest in the environmental sciences.

The library is responsible for the maintenance and on-going development of an extensive collection of environmental reports and periodicals. At present, the library collection holds over 25 000 books and reports, and over 600 journal subscriptions are received throughout the province. Other services include the ordering of all paid publications, including journals for departmental staff; the provision of reference and interlibrary loan service; and the development of regional office library services.

The main library collection is located in Edmonton; a branch library has been developed for the Calgary regional office, and two office collections exist in Lethbridge. The library maintains a reading room in Peace River, and is also assisting the Grande Prairie regional office to establish a reading room for a small book and periodical collection. The library co-operates with the library of the Alberta Environmental Centre in Vegreville, sharing resources by means of the interlibrary loan service.

Use of the library's resources continues to increase. More than 12 000 people used the library in the fiscal year 1981/82. Library staff handled approximately 3600 directional and quick-reference questions, and provided in-depth information in response to 540 questions. Eighty of these included on-line (computer-assisted) bibliographic data base searches. Regional offices relied heavily upon the main library's collection and services.

As always, interlibrary loan service played an important role in providing access to other collections. Over 2000 items were requested from other libraries (four times last year's requests). In addition, other agencies' libraries and consultants borrowed nearly

1800 publications from the Environment Library (a 22% increase over 1980/81). Regular borrowing service from the University of Alberta libraries continued.

The departmental libraries of Environment, Agriculture, and the Alberta Research Council are progressing with a co-operative library automation project (Sci/Tech). Since 1982 January 01, our library has been recording new additions on this computerized system, rather than in the card catalogue. Some 4000 of our records have been converted from cards to the Sci/Tech data base, and we hope to greatly increase this conversion in the coming year.

The comprehensive Bibliography of the Athabasca Oil Sands Fort McMurray, Alberta Area: Socio-economic and Environmental Studies, published in January of 1980, has been updated. The supplement will be available by the summer of 1982.

PROJECTSSCI/TECH Data Bank

An ongoing co-operative project on the part of three large government libraries facilitating automation of the library catalogues (list of holdings). Data from card catalogues are being converted to this automated system and various microfiche and paper catalogues are being produced for easier access by all staff.

Funding: \$100 000.00 (Jointly funded by Alberta Environment Library, Alberta Agriculture Library, and Alberta Research Council Library)

PUBLICATIONS

- Bram, S. 1982. A bibliography of the Athabasca Oil Sands Fort McMurray, Alberta area: socio-economic and environmental aspects - supplement. Alberta Environment Library, Edmonton. 250 pp.

Committees

COMMITTEES

Committees which have Research Management Division representation are listed below.

DEPARTMENTAL COMMITTEES

Acid Deposition in the Environment Departmental Committee

Air System Research Committee

Airshed Management System Quality Assurance Board

Directors/Assistant Deputy Minister Environmental Protection Services Committee

Library Committee

Reclamation Research Co-ordinating Committee

Waste Management Research Committee

INTERAGENCY

Acid Forming Emissions in Alberta and their Ecological Effects Organizing Committee (Alberta Environment, Canadian Petroleum Association, and Oil Sands Environmental Study Group)

Air Pollutants Effects Phase II Committee (Oil Sands Environmental Study Group)

Alberta Environmental Research Trust Grants Advisory Committee

Alberta Environment Centre Technical Advisory Committee

Alberta Fishways

Alberta Government Libraries Council

Alberta Petroleum Industry/Government Environmental Committee:
Steering Committee on Acid Gases in the Environment (SCAGE)

Alberta Petroleum Industry/Government Environmental Committee:
Steering Committee on Acid Gases in the Environment; Solar and Wind
Energy Research Program Subcommittee.

Alberta Petroleum Industry/Government Environmental Committee:
Steering Committee on Acid Gases in the Environment;
Terrestrial-Aquatic Subcommittee

Atmospheric Sciences Program Committee (Alberta Research Council)

Canadian Climate Planning Board (Environment Canada)

Canadian Council of Resource and Environment Ministers, Climate Change Seminar Steering Committee

Canadian Land Reclamation Association

Canadian Petroleum Association/Environmental Research Advisory Committee

Cumulative Impact Group

Forest Development Research Trust Grants Advisory Council

International Committee for the Third Forum on the Human Side of Energy

International Peat Society, Commission III. Bog Cultivation and Afforestation

International Symposium on Acoustic Remote Sensing of the Atmosphere and Oceans, 1981 Advisory Committee (University of Calgary)

Lake Wabamun Scientific Advisory Committee

Lake Wabamun Watershed Advisory Committee

Long Range Transport of Atmospheric Pollutants in Western Canada (LRTAP) Science Committee (Environment Canada)

Long Range Transport Atmospheric Pollutants in Western Canada (LRTAP) Technical Committee (British Columbia, Alberta, Saskatchewan, Manitoba, Northwest Territories, and Canada)

National Research Council; Environmental Secretariat Associate Committee on Scientific Criteria for Environmental Quality

National Research Council; Environmental Secretariat Panel on Hydrogen Sulphide in Atmospheric Environments

National Research Council; Environmental Secretariat Subcommittee on Air

Ninth Annual Aquatic Toxicology Workshop Organizing Committee

Oil Sands Environmental Study Group; Reclamation Research Technical Advisory Committee; Shrub and Soils Subcommittee

Peace-Athabasca Delta Monitoring Committee (Department of the Environment, Department of Energy and Natural Resources, Environment Canada)

Peace-Athabasca Implementation Committee: Monitoring Committee

Peace-Athabasca Implementation Committee: Fisheries Subcommittee

Plains Aquatic Research Conference Organizing Committee

Plains Aquatic Research Group

Plains Coal Reclamation Research Program Steering Committee

Prairie Provinces Water Board

Reclamation Research Co-ordinating Committee

Reclamation Research Technical Advisory Committee

Second International Forum on the Human Side of Energy Steering Committee

South Saskatchewan River Basin Planning Project, Planning Committee

Statistical Co-ordinating Committee

Surface Water Research Advisory Committee (Alberta Research Council and Department of Environment)

Transboundary Movement of Air Pollutants Technical Committee (Alberta, Saskatchewan, and Canada)

United States-Canada Transboundary Air Pollution Impact Assessment Group (Environment Canada)

